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ABSTRACT

Included in this model are five activities dealing with air quality and sources of air pollution in the urban environment. Activities included are: (1) the nature of the atmosphere; (2) discussion of major pollutants; (3) measuring air quality; (4) inversions; and (5) pollution control. Also included are an overview, teacher background information, an activity preview, a pretest, and a module evaluation form. (RE)

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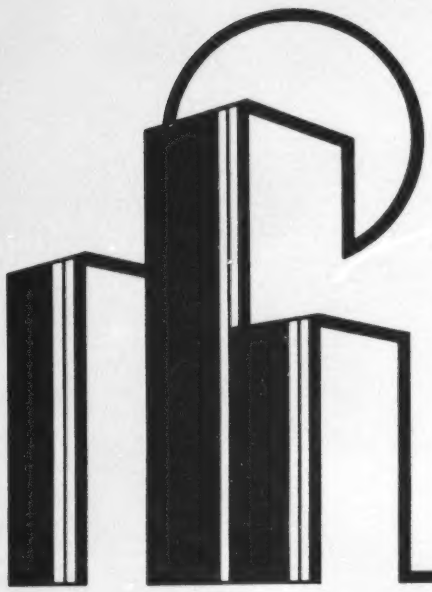

Curriculum Module V

Urban Environmental Education Project

Urban Air Quality: At What Costs?

developed by Barbara Biglan

SE 030 516

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URBAN ENVIRONMENTAL EDUCATION PROJECT

Curriculum Module V

Urban Air Quality: At What Costs?

developed by

Barbara Biglan

August 1979

Catherine Cornbleth, Curriculum Series Editor
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Urban Air Quality: At What Costs?

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Urban Air Quality: At What Costs?

OVERVIEW

Today, in our own country and around the world, there is a growing feeling of crisis about the physical environment of our urban areas. The air over some of the cities of the United States has become increasingly polluted and, at times, a true health hazard. We can no longer afford the luxury of assuming that technology will solve all of our environmental problems. Nor can we continue to manage our resources according to the view that "progress" should prevail at the expense of the environment.

Our urban air pollution problems are not recent ones. Even ancient Romans complained of the sooty smoke that covered their city. In the past, people could leave pollution behind and move to new areas. However, increasing industrialization has concentrated population in urban areas. The economic pressure of employment keeps the population concentrated in these industrial centers. Today, for many people, there is no escape from air pollution.

Air pollution occurs whenever the composition of the air is altered by the addition of harmful substances (substances detrimental to living things). A major source of these pollutants is the burning of fossil fuels (oil, gas, coal).* Urban areas with industrial complexes suffer fossil fuel pollution from both industry and automobiles. Typically, as manufacturing and automobile density decreases, the air quality improves. How can city dwellers deal with air pollution problems? How can both clean air and jobs be maintained? What trade-offs are we willing to make?

Certainly, facts need to be assembled and analyzed before reasonable decisions can be made. Personal and social values also will play a role in determining our future. Both industry and private citizens need to examine the interrelationships among air quality, employment, health, economic costs, and the quality of life in urban environments.

*Pollution also occurs naturally. For example, in the Smoky Mountains haze (smog) results from the reaction of sunlight with the hydrocarbons emitted by trees.

Urban Air Quality: At What Costs?

TEACHER BACKGROUND INFORMATION

We live at the bottom of an ocean -- an ocean several hundred miles deep. It is an ocean of air. Because we cannot see "clean" air or taste it or feel it, we sometimes forget that air is made up of chemical elements and compounds. Air is approximately 78% nitrogen, 20.9% oxygen, .93% argon, .04% carbon dioxide; the rest is rare gases or water vapor. When any substance alters this chemical composition of air, the air is "polluted."

There has been a growing effort by both government and citizens groups to monitor and improve air quality. Levels of certain chemicals -- nitrogen oxides, sulfur oxides, hydrocarbons, ozone -- are recorded by monitoring equipment. The readings from various stations are made available to the public. When we look for the source of these pollutants, we need look no further than our own lifestyles. The automobile, fireplaces, and power generating plants as well as industries put pollutants into the air on a daily basis.

These pollutants not only make the air appear hazy and smell bad, but can aggravate serious health conditions. Both human life and property can be damaged when the pollutants combine with other chemicals in the air or water vapor. Usually, irreversible harm only occurs with very high pollution concentrations. However, adverse health effects can occur with long term, low levels of pollution.

In the past, cities were built up around easy transportation routes (usually rivers). Industries were built where access to raw materials was

easiest. People lived near where they worked; the automobile was a luxury, not a necessity. As industries grew, employment grew. More homes meant more smoke in the skies. Bigger industrial plants meant more smoke in the skies. More automobiles meant more smoke in the skies. We have begun to deal with air pollution issues. It is expensive and time consuming to monitor and limit air pollution. But, our survival and the quality of our lives depend on our facing the issues of air pollution now.

PITTSBURGH: The Mighty, The Smoky, The Beautiful*
William C. Duckworth, III

That Pittsburgh still fights the label "The Smoky City" is well-known to everyone who calls the city home. Visitors greeted with a clear view of the city as they emerge from the Fort Pitt Tunnel frequently express surprise at the absence of smoke. It is almost as if they had been cheated of witnessing the legendary inferno which they had thought was Pittsburgh.

Yet while Pittsburghers congratulate one another for victory over air pollution, which of course is a battle still going on, it must be understood that the city worked long and hard while earning that label.

From its very beginning, Pittsburgh has made its fame as an industrial giant, aided by a strategic location at the point of three broad, navigable rivers in the heart of coal country. Soft coal was abundant and cheap. Everyone burned it; and, as the iron and steel industries grew, so too did the population and the smoke problems. Stephan Lorant, in his book, Pittsburgh, quotes Major Samuel Forman who, in 1790, visited the city (population 500) and said it was filled with "such smoke and dust as to affect the skin of the inhabitants."

The heavy reliance on coal continued both domestically and industrially, creating a thick wall of smoke which hung over the area throughout the nineteenth century and well into the twentieth.

Yet for Pittsburghers, smoke was an acceptable nuisance. It was a sign of prosperity and evidence of Pittsburgh's burgeoning industry and growing railway lines. But as handsome new buildings blackened a proud downtown, and as ailments such as the "Pittsburgh lung" spread among its people, the "nuisance" became less tolerable. Civic leaders, particularly the Chamber of Commerce, began to investigate smoke control.

*Reprinted with permission from Interactions, Spring 1978, pp. 1,6. (Quarterly publication of the Leonard S. Mudge Environmental Education Program, Section of Education, Carnegie Museum of Natural History, Carnegie Institute, 4400 Forbes Avenue, Pittsburgh, PA 15213.)

Health Problems Bring Regulations

The first ordinance was passed by the City Council in 1892 but it had little effect. By the turn of the century there was a growing uneasiness among medical groups over the climbing pneumonia rate, which, by 1912, was reported as the highest in the world by the Pittsburgh Sun-Telegraph. By 1914, a new Bureau of Smoke Regulation was created to enforce the new abatement law of the same year. Fines were given to companies who emitted more than ten minutes of heavy smoke an hour. Although industry took steps to clean up, the ordinance was weak, the bureau was grossly understaffed, and domestic coal burning continued unchecked. By 1939 the agency was abolished.

However, public thinking changed dramatically the following year. St. Louis had been competing as America's smokiest city until it passed the most stringent smoke ordinance in the country. That was 1940, and by the next year St. Louis saw spectacular results.

Civic pride demanded that Pittsburgh solve its problem. The City Council, moving with lightning speed, passed in 1941, the most comprehensive smoke ordinance in Pittsburgh's history. Both domestic and industrial coal consumers were included in the law, which provided stiff penalties for discharging more than 40 percent black smoke. Unfortunately, war intervened. Steelmaking took priority, and pollution levels reached their highest peaks of all time.

Life returned to normal in 1945, and new provisions were added to the 1941 regulations. Smokeless fuel was to be burned and fly ash emissions, today known as particulates, were to be monitored. The citywide ordinance went into effect in 1947.

Although the smoke problem was improving, the Donora Fog of October, 1948 spurred Allegheny County into implementing controls out to its boundaries. After 20 deaths in the Donora area, the county passed in 1949 an ordinance more stringent than Pittsburgh's: fly ash was to be closely curtailed. As a result of both city and county pressures, railroad and riverboat lines replaced coal-fired boilers with oil-burning diesel engines, and homes converted to clean natural gas. By 1956, only ten percent of the homes in Allegheny County continued to burn coal as a source of heat.

The very next year, 1957, city and county efforts were combined in the County Health Department's Bureau of Air Pollution Control. The new agency was to coordinate local research and implement air pollution controls throughout the area.

By 1960, Pennsylvania, after being urged for a decade by Pittsburgh and Allegheny County, finally established an Air Pollution Commission to study scientific findings, set standards, and make recommendations for air control. Research into air pollution, begun by the University of Pittsburgh and Mellon Institute in 1914, was given its greatest stimulus to date.

Research Sets the Pace

From this point on, with the aid of the federal government, scientific study into the effects of air quality became far more sophisticated, and the legislation far more reaching. Research stayed one step ahead of the setting of standards throughout the fifties, sixties and on to the present moment. But as the smoke lifted, the more subtle, toxic, chemically complex side of air pollution became apparent.

In 1967, the state delegated to the county the authority to set the first standards for gaseous emissions such as carbon monoxide, the sulfur dioxides, hydrogen sulfides and nitrogen oxides. This was followed in 1970 by new federal legislation strengthening the Clean Air Act of 1965 under the U. S. Department of Health, Education and Welfare. Health-related air quality standards became mandatory instead of persuasive. The county established monitoring stations to protect the public and to alert the Bureau of Air Pollution Control officials in case unhealthful pollution levels were reached.

By 1972, the county further reduced emission limits. Fines for violations were stepped up. From this time on, the dispute was out in the open.

The High Price of Pollution

Steelmakers and other industries denounced standards as too severe too soon, pollution equipment too costly, and cancer research on animals too inconclusive. But an ever-increasing outcry rose from citizens groups, especially the Group Against Smog and Pollution (GASP) and Enviro-SOS. Strengthened by federal and local air pollution regulations, the ranks of these organizations were likened to a religious crusade for cleaner air. Finally in 1975 and 1976, the last of industry's original smokemakers signed agreements with the county, the state and the U.S. Environmental Protection Agency (EPA) to comply with the latest county emission standards.

At the present time, the County Bureau of Air Pollution Control reports a 50 percent reduction in particulates and sulfur dioxide since 1970. Nevertheless the region does not meet federal standards for four out of five air pollutants, and remains one of several hundred non-attainment areas.

Now in effect are approximately a dozen formal compliance programs which the Bureau of Air Pollution Control has negotiated with non-complying sources of pollution. These are being continuously monitored to make certain that existing air quality meets enforcement schedules. Meanwhile government agencies continue to bring these sources to terms under ever-tightening deadlines and new penalties.

The common thread throughout Pittsburgh's history of air quality has been the strong concern of its citizens. This concern changed to worry and a need for research and technology. Local regulations became state laws and finally national legislation. There can be little doubt the most potent force orchestrating public feeling was the threat air pollution posed to basic health.

ACTIVITY PREVIEW

This module contains five activities, each of which involves a minimum of 45 minutes of class time. Supplementary experiences also are provided, which would increase the time needed.

Activity 1. The Air Is Everywhere, But What Is It?

Given a brief description of the chemical composition of air, students compare clean and dirty air. The Pollutant Standards Index (PSI) is explained, and students analyze a week of PSI reports.

Activity 2. Who Are The Offenders

Students examine the air pollution potential of the automobile, read descriptions of prime pollutants, and pick the worst offender.

Activity 3. Air Quality -- Where?

The Allegheny County air quality monitoring system is reviewed and mapped. Then, students locate potential monitoring sites and prime residential areas.

Activity 4. Inversion -- A Deadly Condition

The whys and wherefores of a temperature inversion are presented. Students plot air temperature and altitude to gain understanding of an inversion. Questions are raised concerning community preparedness and reaction during an inversion.

Activity 5. Pollution Prevention -- Where Do We Stand?

This decision-making activity involves students in establishing priorities and making reasoned choices regarding urban air quality.

NOTE: A knowledge pretest for students, reprinted on the following pages, is provided in the Student Materials Packet.

Urban Air Quality: At What Costs?

MODULE PRETEST

1. An atmospheric condition creating stagnant air and polluted conditions is called

    a. inversion.
    b. conglomerates.
    c. troposphere.
    d. ratio.

2. The major urban air pollutant is

    a. hydrocarbon.
    b. carbon monoxide.
    c. soot.
    d. sulfur dioxide.

3. Air that is altered due to the addition of harmful substances is

    a. inverted.
    b. dioxide.
    c. polluted.
    d. stagnant.

4. A measure of the quality of the air we breathe is the

    a. B.T.U.
    b. C.I.D.
    c. P.S.I.
    d. T.A.Q.

5. Which of the following is <u>not</u> a fossil fuel?

    a. oil
    b. coal
    c. gas
    d. sunlight

6. A byproduct of gasoline engines, also known as the "silent killer," is

    a. ozone.
    b. sulfur oxide.
    c. carbon monoxide.
    d. oxygen.

7. Humans as well as all other animals need this gas to survive.

   a. carbon dioxide
   b. oxygen
   c. carbon monoxide
   d. nitrogen

8. Materials such as soot, ash, and other residues are called

   a. hydrocarbons.
   b. pyroclastics.
   c. particulates.
   d. oxides.

9. The major source of oxygen is

   a. green plants.
   b. animals.
   c. fossil fuels.
   d. fungus.

10. The two major sources of air pollution are

   a. forest fires and industry.
   b. inversions and P.S.I.
   c. automobiles and industry.
   d. power plants and forest fires.

ACTIVITY 1. The Air Is Everywhere, But What Is It?

Objectives: In this activity, students distinguish "normal" clean air from "polluted" dirty air by comparing relative percentages of chemicals; match PSI ratings with good, unhealthful, and hazardous air conditions; and interpret and evaluate the air quality readings for a hypothetical week.

Organizing Ideas:

1. Normal air is composed of 78% nitrogen, 21% oxygen, .04% carbon dioxide, .93% inert gases, water vapor, and dust.
2. Air pollution occurs when the chemical composition of the air is altered either by changes in the "normal" proportion of chemicals or by the addition of other chemicals.
   a. The Pollutant Standards Index is a measure of the quality of air we breathe. It provides both numerical and qualitative measures of air quality.
   b. Air conditions, which change on a daily basis, can be altered by weather patterns as well as "man-made" pollutants.

Resources:

Any junior high level general science text

GASP's PSI pamphlet. (Group Against Smog and Pollution, P.O. Box 5165, Pittsburgh, PA 15260)

Daily PSI readings available by phone, 412/466-0580

Slide series (12 slides) and accompanying script describing air quality in the Pittsburgh area, past and present. (Available from the Urban Environmental Education Project, Allegheny Intermediate Unit, Two Allegheny Center-Suite 1300, Pittsburgh, PA 15212.)

Student Materials:

Handouts (provided in the Student Materials Packet)

The Air Is Everywhere, But What Is It? (SM 1.1, 1.2)

What's the PSI, Ocean-Dweller? (SM 1.3, 1.4)

Suggested Procedures:

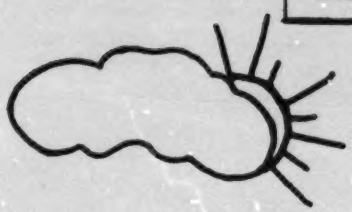
1. This activity is designed to be largely self-instructional, with students completing the handouts, SM 1.1-1.4, individually.

   a. In the air quality comparison of Bottle X and Bottle Y, SM 2.1, some trade-offs must be made. Very few areas on the earth have "normal" air (and "normal" is not the same everywhere). A housewife may not want the dust in the air. A person with lung or heart disease probably will be more wary of chemical pollutants. If students are not familiar with the effects of these pollutants, they might refer to the fact sheets provided with Activity 2. (This section might be extended with an examination of how the kind(s) of pollution in our air differ from one region to another. The pollutants measured at various sites in the Pittsburgh area (see SM 3.1) are suggestive of some of these differences.)

   b. The PSI readings section, SM 1.3-4, can be expanded by asking students to record and report daily PSI readings for particular monitoring stations for a week or longer. In addition, a visit to one of the monitoring stations (e.g., downtown at the Court House) might be arranged. Alternatively, students might visit an area near an industrial plant or major highway to observe the effects of industrial and/or auto pollution on the air, buildings, and plant life.

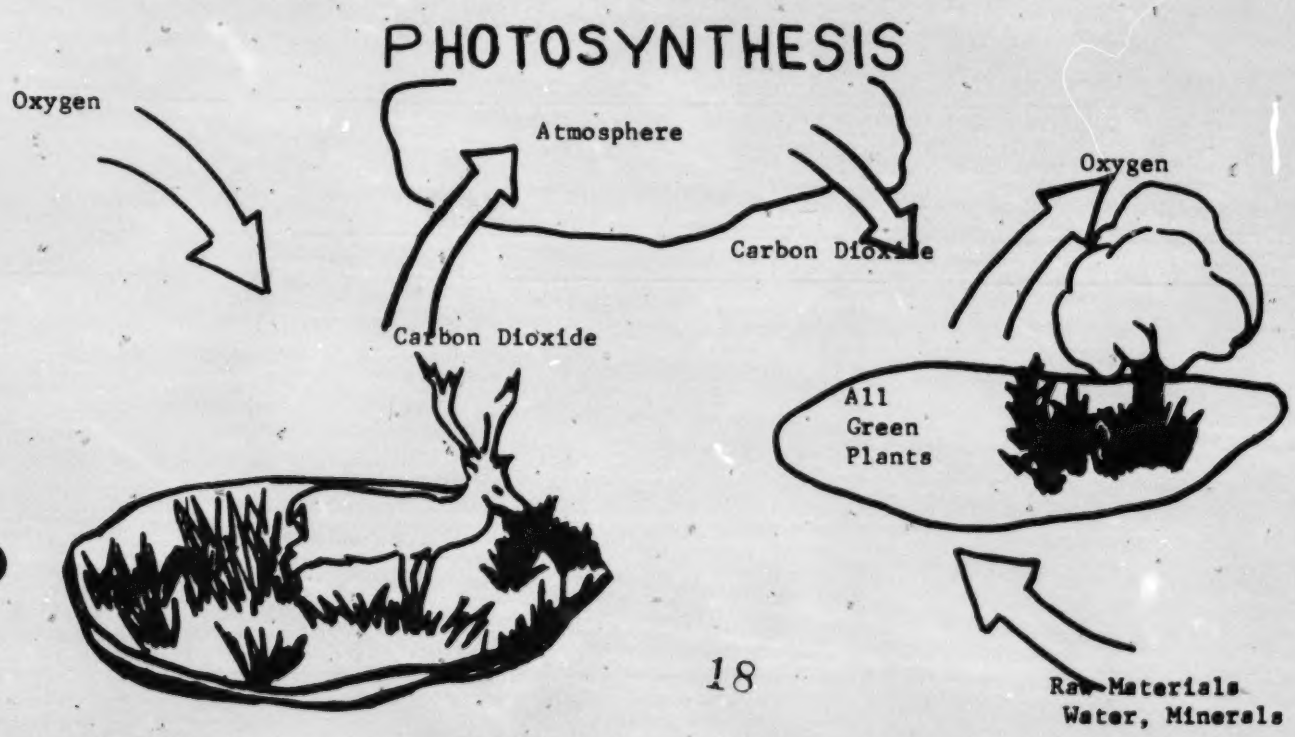
2. The series of 12 slides and accompanying script, depicting air quality then and now in the Pittsburgh area, might be used before or after introducing the PSI, SM 1.3-4, to illustrate air pollution problems and progress. As a follow-up, students might take similar photographs in their own community and compare their findings with the scenes in the slide series.

The Air Is Everywhere, But What Is It?



Greetings ocean dweller! It has been said that we live in an ocean of air approximately 16 km deep. Just as fish, mammals, and plants require certain things to maintain life in the water ocean, we need a clean ocean of air for our life to continue. What's in clean air? How do we know how dirty our air is? What can change our air ocean? Remember, ocean dweller, the quality of your life in this ocean depends upon the answers to these questions. Read on and keep breathing!

Air is a renewable resource. The presence of green plants exchanging oxygen for carbon dioxide helps restore the oxygen we use up in breathing. Air normally contains certain gases. "Normal" air is odorless. It contains 78% nitrogen gas, 21% oxygen gas, .04% carbon dioxide and .93% rare gases (argon, helium xenon, krypton). If other chemicals are added to the air, the proportion of "normal" gases changes, which affects air quality.

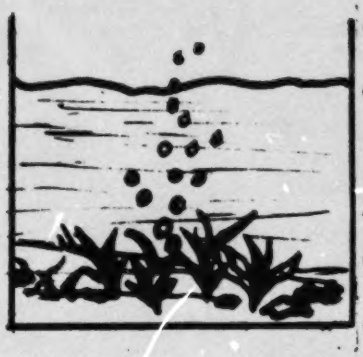


Ocean-Dweller, assume that you have been given two bottles of air, Brand X and Brand Y.

Brand X	%	Brand Y	%
Nitrogen	77.	Nitrogen	77.
Nitrogen oxides	1.	Nitrogen oxides	1.
Oxygen	20.8	Oxygen	21.
Carbon dioxide	.0(	Carbon dioxide dust particles	.06
Carbon monoxide	.08		
Sulfur dioxide	.04		

Which bottle contains the air you prefer to breathe? Why did you pick that bottle?

What's The PSI, Ocean-Dweller?



The PSI is the Pollutant Standards Index, a measure of the quality of air we breathe. It is a nationally uniform index recommended by the United States Environmental Protection Agency. Measurement is given in a numerical range of 0 to 500. These numbers refer to the amount of particulates, ozone (smog), sulfur dioxide, and carbon monoxide in the air.

Less than 100 = Clean Air

0 to 50 = Good Air

51 to 100 = Moderate Air

More than 100 = Dirty Air

101 to 200 = Unhealthful Air

201 to 300 = Very Unhealthful Air (A First Stage Alert)

301 to 400 = Hazardous Air (A Second Stage Alert)

401 to 500 = A Third Stage Alert

During one week, the following PSI readings were given on the evening news weather reports:

Monday:	Downtown	50
	Liberty Borough	100
	Hazelwood	80
Tuesday:	Downtown	100
	Hazelwood	150
Wednesday:	Downtown	100
Thursday:	Downtown	150
	Liberty Borough	200
	Hazelwood	200
Friday:	Downtown	80
	Liberty Borough	100
	Hazelwood	100

Use this information to fill in the following chart.

Air Quality Station	Days of the Week				
	M	T	W	Th	F
Downtown	50	—	—	—	—
Liberty Borough	—	—	—	—	—
Hazelwood	—	—	—	—	—

(If no report was given, mark an X.)

1. When was air quality the best in downtown?

2. Which station reported the poorest air quality on Monday?

3. Which station reported the best air on Thursday?

4. On what day was air quality the worst?

5. Thursday night and earlier Friday morning, a hard rain fell in the area. How did air quality change after the rain?

ACTIVITY 2. Who Are the Offenders?

Objectives: In this activity, students compare the air pollution potential of the gasoline and diesel engines and identify the pollutants responsible for the most damaging effects on the environment.

Organizing Ideas: Major air pollution sources include industries using fossil fuels or carbon in their manufacturing processes, automobiles, private fireplaces, and tobacco smokers.

1. Pollutants can be particulates (e.g., soot, ash) or gases (e.g., carbon monoxide).
2. Just as pollutants have different sources, they have different effects. Some pollutants cause more environmental and health damage than others.

Resources:

Tuberculosis League of Pittsburgh's Pollution Primer. (2851 Bedford Avenue, Pittsburgh, PA 15219)

An informative book, with a detailed presentation of the health problems caused by pollution, including automobile and radioactive fallout pollution.

Air Quality in Allegheny County. Bureau of Air Pollution Control, Allegheny County Health Department, 301 Thirty-Ninth Street, Pittsburgh, PA 15201. 412/681-9600

This illustrated booklet provides a brief history of air quality legislation and progress in the area since World War II, descriptions of major pollutants and their effects, specific sources of pollutants and efforts to reduce pollution, and air monitoring procedures (the section on the

Air Quality Index is now out-dated). A "pocket" in the back cover includes additional, current information, e.g., a pamphlet describing the Pollutant Standards Index (PSI). In addition to literature, the Bureau offers speakers, slide presentations, and "general air quality information."

Eblen, W., Daller, J., and Scrvall, J. The World's Exhaust. West Haven, CN: Pendulum, 1971.

This brief (62 page) book provides an international perspective on pollution causing practices.

Student Materials:

Handouts (provided in the Student Materials Packet)

"Wanted: The Worst Pollutants" (SM 2.1, 2.2, 2.3)

"Wanted" poster-fact sheets (SM 2.4, 2.5, 2.6)

Suggested Procedures:

1. Parts A-D, "Wanted: The Worst Offenders," SM 2.1-3, might be completed individually, with students sharing their responses. Part E is designed to be completed by students working individually or in small groups and followed by presentation of their conclusions and/or informal debate.
   a. In Part A, sources of air pollution range from cigarette and cigar smokers to blast furnaces, from automobiles to cinders used on snow covered highways.
   b. The carbon monoxide computations in Part B might be extended to estimate the amount emitted in the local community or Allegheny County. Also, note that cars vary in the amounts and kinds of pollutants they emit. (A gram is a measure of mass, equal to approximately .032 ounces.

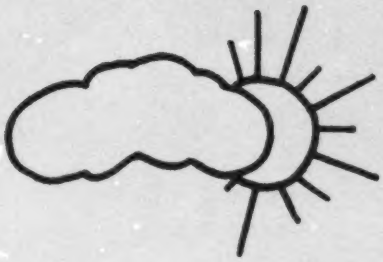
Imagine a "gram of pollution" as a small, thin flat speck of dust (or lint, etc.). To visualize pollution in grams per liter, imagine the number of such specks in a quart of milk.)

c. In Part D, both engines have drawbacks. Encourage students to identify the advantages and limitations of each, including factors other than pollution potential (e.g., energy efficiency, noise, cost, fuel availability). As a skill development supplement to this section, students might graph the data provided here in chart form.

d. This writing assignment might be completed individually, out-of-class, with oral presentations to the class on the following day. Encourage students to provide more than one (health and/or property damage) reason for their choice. Students also might include a picture or drawing of the damage done by their "most wanted" air pollutant.

2. The "Wanted" poster, SM 2.4-6, is a fact sheet intended to provide students with needed background information, particularly for Parts D and E. You might want to review these with students before they begin to work on SM 2.1-3.

Wanted: The Worst Pollutants



Air Ocean Dwellers, we are being invaded by pollutants every day. If not caught and checked, these pollutants will seriously affect the quality of our lives -- and even our survival. First, we must identify the sources and culprits and discover their M.O. (modus operandi).

A. List as many sources of air pollution as you can. We will put as many as possible on our most wanted list.

1. _____ 6. _____
2. _____ 7. _____
3. _____ 8. _____
4. _____ 9. _____
5. _____ 10. _____

B. One source of particularly dangerous pollutants is the automobile. The internal combustion engine burns gasoline for power. After the combustion or burning of the gasoline, many pollutants are emitted from the car by the exhaust system. For example, an auto discharges about one gram of carbon monoxide for every 10 miles traveled. Compute the average daily mileage your parents drive.

On the average, how much carbon monoxide does your family contribute to the air each week? _____

each month? _____

each year? _____

C. Look at the following chart. It compares the emissions from a regular gasoline engine car and a diesel engine car in grams per liter.

	Gasoline Engine	Diesel Engine
Carbon Monoxide	28.5	7.1
Nitrogen Oxides	22.2	12.0
Hydrocarbons	15.8	21.6
Particulates	1.3	13.3
Sulfur Dioxide	1.0	4.8

Now complete these statements:

1. The gasoline engine emits more of the following pollutants than the diesel engine: _____

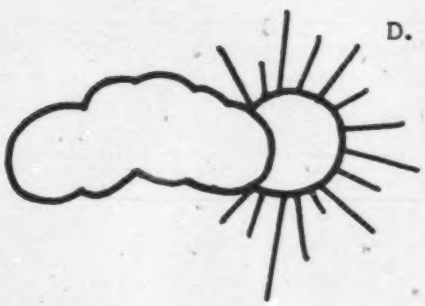
   _____

2. The diesel engine emits more: _____

   _____

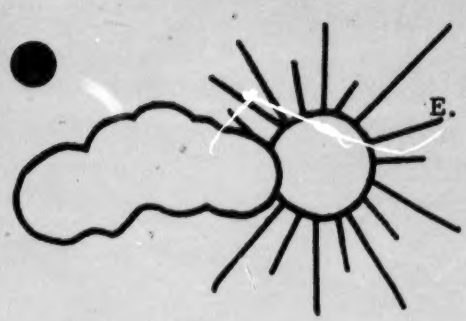
   _____

   _____



D. Air Ocean Dweller, you have won a new car in a contest. The car comes with either a regular gasoline engine or a diesel engine. Which one would you choose?

Why?



E. Ocean dweller, pick your "MOST WANTED" air pollutant. Tell why you think your choice should be the "most wanted." Include where it comes from, the damage it does, and why it is worse than the others.

WANTED

"THE SILENT KILLER" -- CARBON MONOXIDE

"THE BIG BURN" -- SULFUR DIOXIDE

"THE SPECK," alias "THE ASH" -- SOOT

"OZONE," alias "SMOG"

. . .AND OTHER MEMBERS OF THE AIR POLLUTANTS GANG

USUAL HANGOUTS:

-Industries burning fossil fuels (oil, gas, coal) such as steel and electric power plants

-Car exhausts

-Fires (outdoor or indoor fireplaces)

-Manufacturing processes

PHYSICAL DESCRIPTIONS:

Carbon Monoxide -- An odorless gas, which decreases the oxygen carrying ability of the blood

Sulfur Dioxide -- A heavy gas with an unpleasant odor

Particulates ----- Soot, ash, dust or any residue in the air such as microscopic metal or asbestoes

Ozone ---------- A colorless gas formed when nitrogen oxides and certain hydrocarbons react

Hydrocarbons ---- Carbon compounds resulting from incomplete combustion of fuel

TYPES OF POLLUTANTS BY MAJOR SOURCE AND AMOUNT PRODUCED

Pollutant		Source
Carbon Monoxide	52%	Motor vehicles
Sulfur Dioxide	18%	Industry burning fossil fuels
Hydrocarbons	12%	Motor vehicles
Dust; Ash; Soot	8%	Industry burning fossil fuels
Nitrogen Dioxide	6%	Motor vehicles
Other Materials	2%	Burning of organic materials, other manufacturing processes

CRIMES COMMITTED BY POLLUTANTS

Carbon Monoxide can aggravate heart and lung disease; cause fatigue, headaches and slowed reflexes by decreasing oxygen carrying ability of the blood; and form a weak acid which attacks stone.

Sulfur Dioxide can cause and aggravate respiratory irritation and disease. It can combine with water to form a weak acid which attacks limestone and marble. It causes flaking away of buildings. It causes deterioration of paper and leather products and the leaves of green plants.

Particulates can be either solid or liquid and may originate in nature or from industrial processes and other human activities. Particulates cause and aggravate respiratory disease, reduce sunlight, and impair visibility. They can damage plants and materials and just make things look dirty.

Ozone, which is formed from motor vehicle emissions, particularly on hot sunny days, causes respiratory problems and irritates the eyes, nose and throat. Rubber can crack due to the chemical effects of ozone.

Nitrogen Oxides come mainly from auto emissions. When they combine with hydrocarbons on hot sunny days, they form ozone. They can also form an acid that can cause property damage.

ACTIVITY 3. Air Quality -- Where?

Objectives: In this activity, students locate present air quality monitoring stations, list possible sources of air pollution in those areas, locate sites for additional air quality monitoring stations, and identify five low pollution areas in Allegheny County.

Organizing Ideas:

1. Air quality monitoring stations usually are located at specific geographic points where air pollution is likely to be a problem.
   a. Not all possible areas of pollution are presently being monitored.
   b. In certain areas (within Allegheny County), air quality is usually very good.
2. A balance of clean air and nearness to employment, shopping, and recreation is desirable to maintain and enhance the quality of life in urban environments.

Resources:

GASP's Clean Air pamphlet. (Group Against Smog and Pollution, P.O. Box 5165, Pittsburgh, PA 15206)
Includes a comparison of 1976 and 1977 air standards in Allegheny County, a brief description of pollutants, and federal air standards.

Yearly summaries of air quality in Allegheny County, available from the Bureau of Air Pollution Control, Allegheny County Department of Health, 412/578-8111

Gulf Oil Co., Tourguide Bureau, Gulf Bldg., 7th and Grant, Pittsburgh, PA 15219, 412/391-2400

Gulf provides an excellent Pittsburgh area map showing railroads, major highways, steel plants, and parks. The maps are $1.00 at Gulf service stations. However, you may be able to obtain free copies by calling Gulf and indicating that you would like the map for school use.

Student Materials:

Handouts (provided in the Student Materials Packet)

Measuring Air Quality: What and Where? (SM 3.1, 3.2)

Allegheny County Map

How Clean Is Our Air? (SM 3.3)

Felt pens or colored pencils (for map activity)

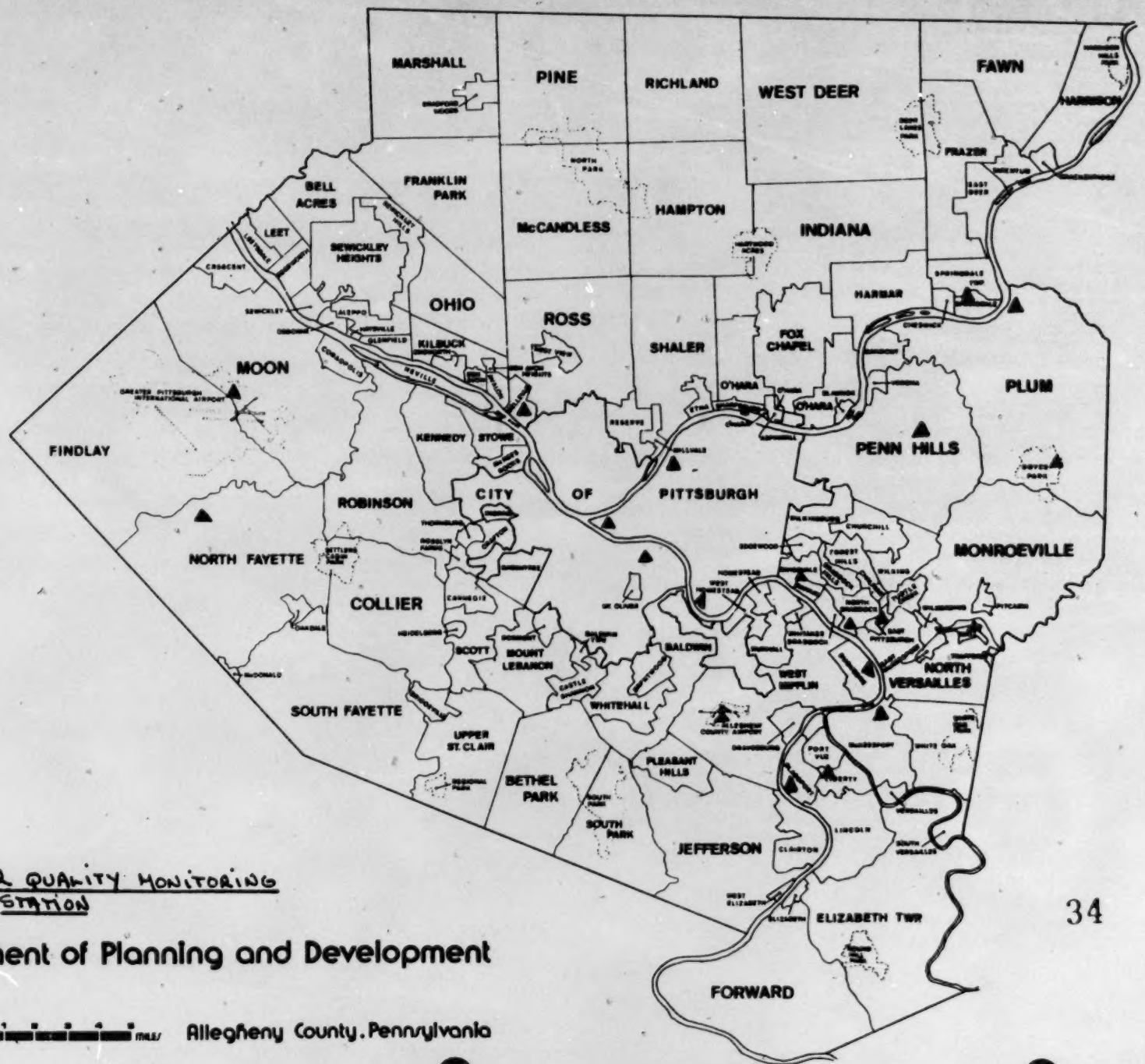
Suggested Procedures:

1. This activity introduces the air quality monitoring system in Allegheny County and sources of pollutants in particular areas. (The locations of the air monitoring stations are indicated on the map that follows.) After the students complete the handouts, encourage them to share their responses and the reasons for their choices.
   a. In locating pollution sources, look for industrial sites, major roadways, and shopping centers. (The Gulf or other maps would be useful references here.)
   b. The geography of the area also might be examined in relation to pollution sources and air quality. (Note that our winds usually move from west to east.)
   c. Students might locate other monitoring stations (in addition to the first 7) and compare the concentration of stations north, south, east, and west of downtown.

d. In response to question #3 on SM 3.2, students might decide not to add monitoring stations because they believe that pollution is not serious in other areas or because they believe that the possible pollution dangers are not great enough to justify the costs of the monitors.

e. Ask students to share their responses to "How Clean Is Our Air?" (SM 3.3), perhaps by acting as realtors trying to sell homes in the areas they have selected. Additional questions for consideration include: Why do people continue to live in (more) polluted areas? Why does your family live in this community?

2. Follow-up: Air pollutants have been found in areas such as Anarctica and Greenland where there is little or no industry or vehicular traffic. Ask students to consider how this might have happened. What are the implications for air quality elsewhere? To what extent is air pollution a global as well as a local problem? (Radioactive fallout from nuclear testing might be explored in this regard.) The Eblen et al. booklet, noted in Activity 2, would be a useful reference here.


MARSHALL
PINE
RICHLAND
WEST DEER
FAWN
HARRISON
FRAZER
FRANKLIN PARK
BELL ACRES
LEET
SEWICKLEY HEIGHTS
McCANDLESS
HAMPTON
INDIANA
OHIO
ROSS
SHALER
HARMAR
FOX CHAPEL
O'HARA
PLUM
MOON
FINDLAY
KILBUCK
KENNEDY
STOWE
CITY OF PITTSBURGH
PENN HILLS
ROBINSON
NORTH FAYETTE
COLLIER
MONROEVILLE
SCOTT
MOUNT LEBANON
BALDWIN
WEST MIFFLIN
NORTH VERSAILLES
SOUTH FAYETTE
WHITEHALL
UPPER ST. CLAIR
BETHEL PARK
SOUTH PARK
PLEASANT HILLS
JEFFERSON
ELIZABETH TWP
FORWARD
AIR QUALITY MONITORING STATION
Department of Planning and Development
MILES
Allegheny County, Pennsylvania

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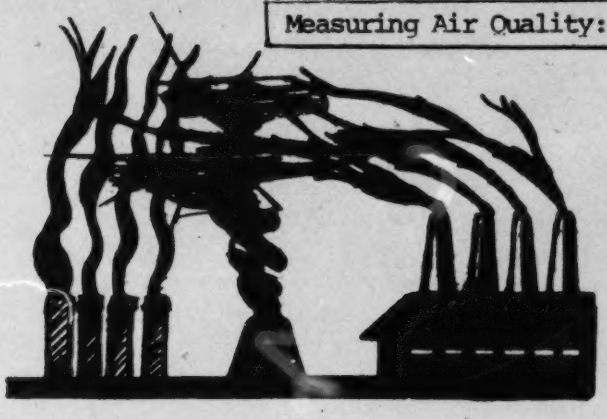
Measuring Air Quality: What and Where?



The following chart lists Air Quality Reporting Stations and the pollutants that are measured at each site.

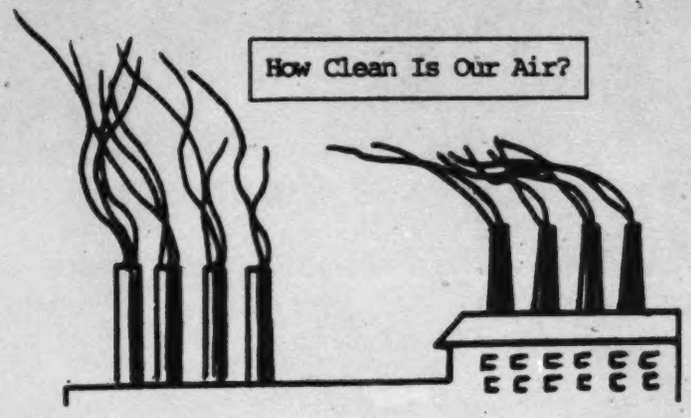
	Station	Particulates	Sulfur	Carbon Monoxide	Ozone
1.	Bellevue	X	X		
2.	Downtown	X	X	X	X
3.	Glassport	X	X		
4.	Hazelwood	X	X		
5.	Liberty Borough	X	X		
6.	Logans Ferry	X	X		
7.	North Braddock	X	X		
8.	Boyce Park			Summer Only	X
9.	Lawrenceville				X
10.	Penn Hills				X
11.	Springdale	X			
12.	County Airport	X			
13.	North Fayette	X			
14.	South Side	X			
15.	Wall	X			
16.	Swissvale	X			
17.	Duquesne	X			
18.	Greater Pitt Airport	X			
19.	East Pittsburgh	X			
20.	McKeesport	X			

1. On the map of Allegheny County, locate the areas served by the first seven Air Quality Reporting Stations. Draw a circle around each area.
2. List at least three sources of pollution in the area served by the Air Quality Monitoring Stations closest to your home.

3. If you believe that more monitors should be located in Allegheny County, where would you place them? What are sources of air pollution at these areas?

	Area	Pollution Sources
a.	_____	_____
b.	_____	_____
c.	_____	_____
d.	_____	_____
e.	_____	_____

If you do not believe that more monitors are needed, indicate your reasons.



For carbon monoxide, the highest readings occur downtown on weekdays, particularly during the morning and evening rush hours. Carbon monoxide levels are usually related to traffic patterns.

For sulfur dioxide concentration during a period ending June 1977, the readings at 6 out of 7 monitoring stations exceeded federal annual standards. The most excess sulfur dioxide was at Hazelwood and Liberty Borough.

For particulate matter, the readings at only 6 monitoring stations met federal standards for the year ending June 1977. These six monitoring stations were North Fayette, Springdale, Wall, South Side, County Airport, and Logans Ferry; the highest levels were found at the Downtown, North Braddock, Swissvale, Duquesne, and Glassport stations.

Use your map(s) to locate and identify five areas in Allegheny County that you consider low in air pollution. Tell why you would (or would not) consider living in each of these areas. Besides air pollution, consider commuting time to work, to shopping, to recreation, and other factors that are important to you.

1. _____

2. _____

3. _____

4. _____

5. _____

ACTIVITY 4. Inversion — A Deadly Condition

Objectives: In this activity, students read about inversions, plot normal and inverted air conditions by temperature and height, and formulate recommendations to prevent a repeat of the disasterous Donora or London inversions.

Organizing Ideas:

1. Temperature inversions occur when the air temperature increases with increasing altitude and no mixing of air by wind occurs. As a result, pollutants accumulate to hazardous if not deadly levels as has happened in Donora, Pennsylvania, London, and the Meuse Valley in Belgium.
2. Action is needed to remove deadly pollutants from the air during a temperature inversion since only a change in weather factors can remove the inversion.

Student Materials:

Handouts (provided in the Student Materials Packet)

What's An Inversion? What Difference Does It Make? (SM 4.1, 4.2)

Graphing An Inversion (SM 4.3)

Suggested Procedures:

1. The handout, "What's An Inversion? What Difference Does It Make?" SM 4.1-2, explains how inversions form and briefly describes the health effects of three severe inversions. As an optional follow-up, students might complete the graphing exercise, SM 4.3, and/or find out more about one of the major inversions such as the one in Donora, PA in 1948.

2. The Pittsburgh area has experienced several inversions in recent years. While we cannot control the weather, we can control pollution if we want to. Ask students to use their knowledge about air pollution and inversions in considering one or more of the following questions. Also, use follow-up questions to encourage consideration of political, economic, social, and other side-effects.

   a. What recommendations would you make concerning motor vehicle traffic into the downtown area during an inversion?

   b. What recommendations would you make concerning manufacturing and industrial plants during an inversion?

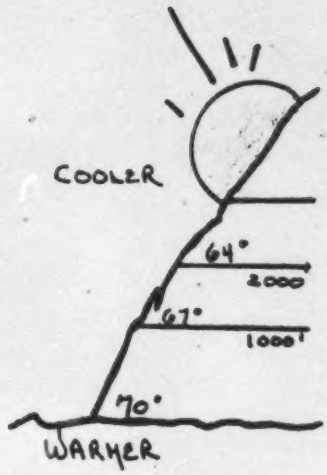
   c. What actions can be taken to prevent or at least minimize serious illness and loss of life during an inversion? What recommendations would you make in the interest of people's health?

   d. In new and developing urban areas, planning can minimize the possibility of inversions. What would you recommend?

   e. What can a community do to prevent stagnant air from developing into an inversion? What recommendations would you make?

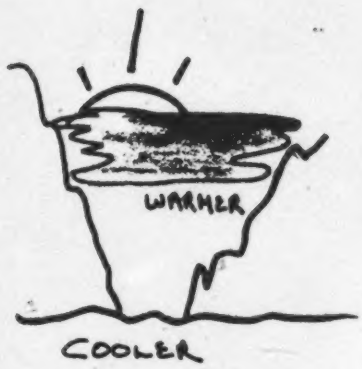
   f. Assume that you are the Mayor of Pittsburgh and that inverted weather conditions have just been reported. What are three or four actions that you would take? Which are most important? (Alternatively, you or designated students might check with local, city, or county officials to find out what their plans are.)

What's An Inversion? What Difference Does It Make?



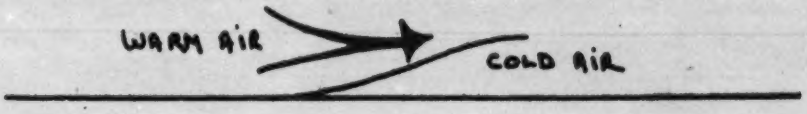
As one moves up into the atmosphere, the temperature decreases with height. This decrease is known as the lapse rate. In lower regions of the atmosphere, the lapse rate is approximately 3.3° F per 1,000 feet (9.6° C per 100 meters). There is fluctuation due to irregular wind movement from various sources at the surface. At times, however, instead of decreasing in temperature with increasing height, the air temperature increases. This process is known as a temperature inversion.

On calm evenings, the ground cools rapidly by radiation; the air near the surface is cooled further. It will generally become cooler than air above it, inverting the normal process. This is especially true in valley areas where the valley walls trap the cool air until the sun is high enough to warm the valley. (At times this phenomena becomes more prominent with fog.)



Inversions also can be caused by the effects of air fronts moving into an area. Warm air is lighter than cool air and rises. When a cold front moves into an area, warm air is pushed up over the colder air, creating an inverted layer.

With an approaching warm front, the air rises over the cold air.



When pollutants accumulate, usually from automobile exhaust and industry, smog is created. Smog is a mixture of smoke and fog.* This mixture may create a barrier that does not allow the sunlight to penetrate, which means that this stagnant air remains as long as no surface winds are present to mix the air.

The inversion acts as a lid on the valley areas, trapping the pollutants below. Inversions not only create atmospheric problems but also health problems for many people. In fact people in many large cities face this threat. Inversions have had devastating effects on human life.

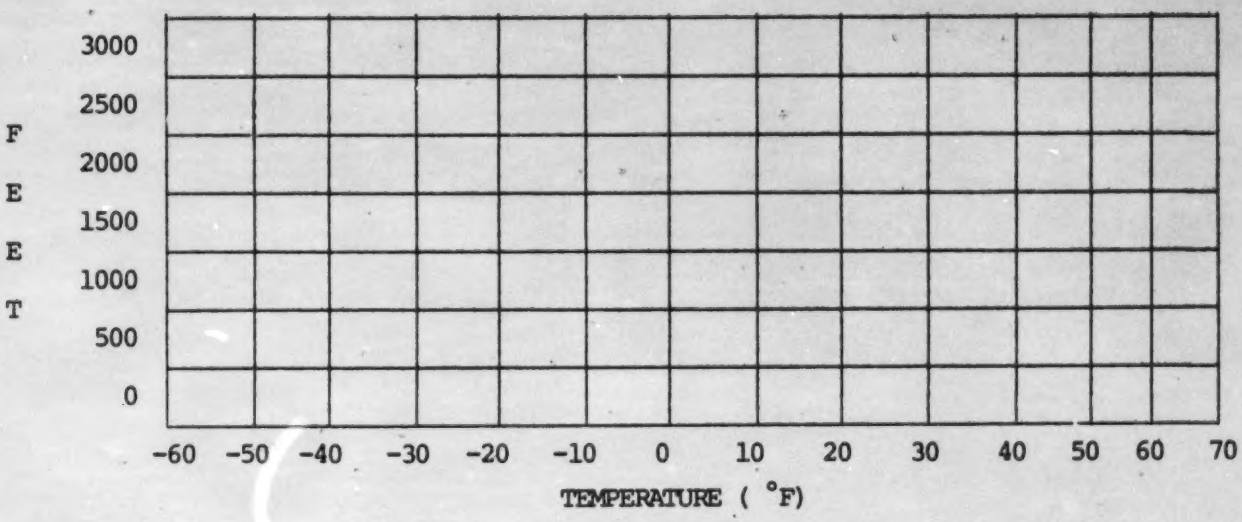
In December of 1930, an inversion enveloped the industrial Meuse Valley in Belgium for more than a week. Residents of this area experienced coughing, chest pains, throat irritations, hoarseness, and nausea. By the time the inversion lifted, over 60 people had died and several hundred had become seriously ill.

Closer to home, in Donora, Pennsylvania, which is located in a narrow valley of the Monongahela River, a similar disaster occurred in October 1948. It left twenty dead and hundreds with the lingering effects of the bad air. Although inversions have occurred frequently in the Mon Valley, the 1948 inversion was the most serious.

In December 1952, another major industrial city was overwhelmed by the accumulation of fog and soot — London, England. For a period of two weeks London was under seige, leaving 4-5,000 dead.

*Smog can also occur as a result of the interaction of sunlight, reactive hydrocarbons and/or nitrogen oxides.

Graphing An Inversion



Plot the following temperatures on the graph using a different color for line I and line II.

Height Feet	I Temperature °F	II Temperature °F
0	60	50
250	50	40
500	40	50
1000	20	65
1500	-10	40
2000	-20	20
2500	-40	0

Which line, I or II, illustrates a temperature inversion?

Circle the temperature inversion on your graph.

ACTIVITY 5. Pollution Prevention -- Where Do We Stand?

Objectives: After sharing and reviewing their findings about air pollution sources and effects, students complete a decision-making map for an air quality-urban environment goal. (To complete the map, students clarify the issue and the goal, select what appear to be the three most promising (air quality) options, identify the likely consequences of each, and make a tentative decision based on the available evidence and their own value priorities.)

Organizing Ideas:

1. Sound decisions require consideration of alternative responses in terms of the available evidence and one's values.
   a. Each air quality option has advantages and disadvantages.
   b. There is no ideal means of maintaining or improving air quality; when health, environmental, economic, and other factors are considered, no option is ideal.
2. In a democratic socio-political system, both individual and group choices and actions influence environmental policy decisions and outcomes.
   a. Individual responsibility
   b. General welfare
   c. Trade-offs

Student Materials:

Handouts (provided in the Student Materials Packet)

Pollution Prevention: At What Costs? (SM 5.1, 5.2)

Trade-Offs (SM 5.3)

Decision-Making Map

Transparency (provided in the Student Materials Packet)

Decision-Making Map (same as handout)

Suggested Procedures:

1. Since the overall purpose of this module is to encourage and assist students to make reasoned decisions about a crucial urban environment-quality of life issue, it is desirable to review the students' findings from previous activities, to explain the decision-making map and process, and to communicate the importance of informed citizens making thoughtful choices.
   a. The decision-making map transparency might be used alone or in conjunction with the handout to explain the process.
   b. The handout, "Pollution Prevention: At What Costs?" (Sm 5.1-2) provides students with additional background information and encourages them to examine their own values. Students might be asked to note other "considerations"in addition to the three mentioned.
2. The "Trade-Offs" worksheet, SM 5.3, is intended to be used as a lead-in to the decision-making process (clarifying the issue and the goal, identifying options).
   a. In completing question #3, students might add items from question #1. Afterward, they might reconsider the goal they selected in question #2.

b. Consensus regarding an air quality goal is desirable since air quality is a public policy issue more than a matter of personal choice. Once a common goal has been determined, move to the decision-making map, and ask students to consider ways in which their goal might be reached.

3. Questions such as the following might be raised to stimulate group discussion and guide decision-making:

   a. What might be done to achieve our goal? (What else?)

   b. What difficulties might be encountered in doing that?

   c. How would doing that change your life? (What would you personally contribute to reach this air quality goal? What would you be willing to do (or, do without) to achieve this goal? What trade-offs are you willing to make?)

   d. Who else would be affected? (In what ways?)

   e. How much difference would that make? (What are the costs? The benefits? What else might be needed?)

   f. Which route to our air quality goal seems to be the best?

4. Follow-up options include examining ways in which students might act on their decision(s) and "monitoring" air quality legislation and outcomes in the local area.

Pollution Prevention: At What Costs?

Each year approximately 190,000 tons of particulate matter and 300,000 tons of sulfur dioxide are emitted into the air of Allegheny County. Where do these air polluters come from? Power for both home and industrial use accounts for about half of the particulate matter and more than half of the sulfur dioxide. Two steel companies contribute another 40,000 tons of particulates and 60,000 tons of sulfur dioxide. Together the power companies and the steel companies contribute a lot of pollution to our air.

Where does the rest of the air pollution come from? Some comes from automobiles, buses, and trucks. The gasoline and diesel engines put carbon monoxide, particulates, sulfur dioxide, nitrogen oxides, and hydrocarbons into our air. Some manufacturing processes emit sulfur dioxide or particulate matter into the air. Even a backyard barbeque emits particulate pollution.

What will we do about these pollution sources? Before you throw a bucket of water on your neighbor's barbeque, consider the following:

1. Our modern day quality of life is made possible by many electrical devices, for example, washing machines,dishwashers, hair dryers, and televisions. Generating the needed electrical power "costs" a certain amount of sulfur dioxide and particulates.
2. Steel making and other manufacturing processes also pollute the air, but are responsible for employing many people in Allegheny County. If the steel mills are shut down, people will lose jobs, steel prices will rise, and many products will increase in cost. If steel manufacturers limit their "emissions," the cost of emission controls is

likely to increase the price of steel (and cars, appliances, etc.).

3. The automobile is also a source of air pollution, but many people enjoy driving to work, to recreation, and to shopping. The geography (hills) of Allegheny County presents some problems to proposed bikeways and alternate modes of transportation.

Our urban areas need power, manufacturing, and industry as well as recreation to provide their citizens with a satisfactory lifestyle. We also need clean air to breath. Our future depends upon the balance we strike between clean air and our other needs. Where do you stand?

Trade-Offs

How can we maintain and improve the quality of life in urban environments? How might we balance the seemingly conflicting goals of healthy air, jobs, and personal convenience? What are the trade-offs? What compromises are you willing to make?

---

1. Begin by considering what is most important to you. Here are some suggestions. Add other things that are important to you. Then rank each item as follows:

   1 = very important to me
   2 = moderately important to me
   3 = less important to me

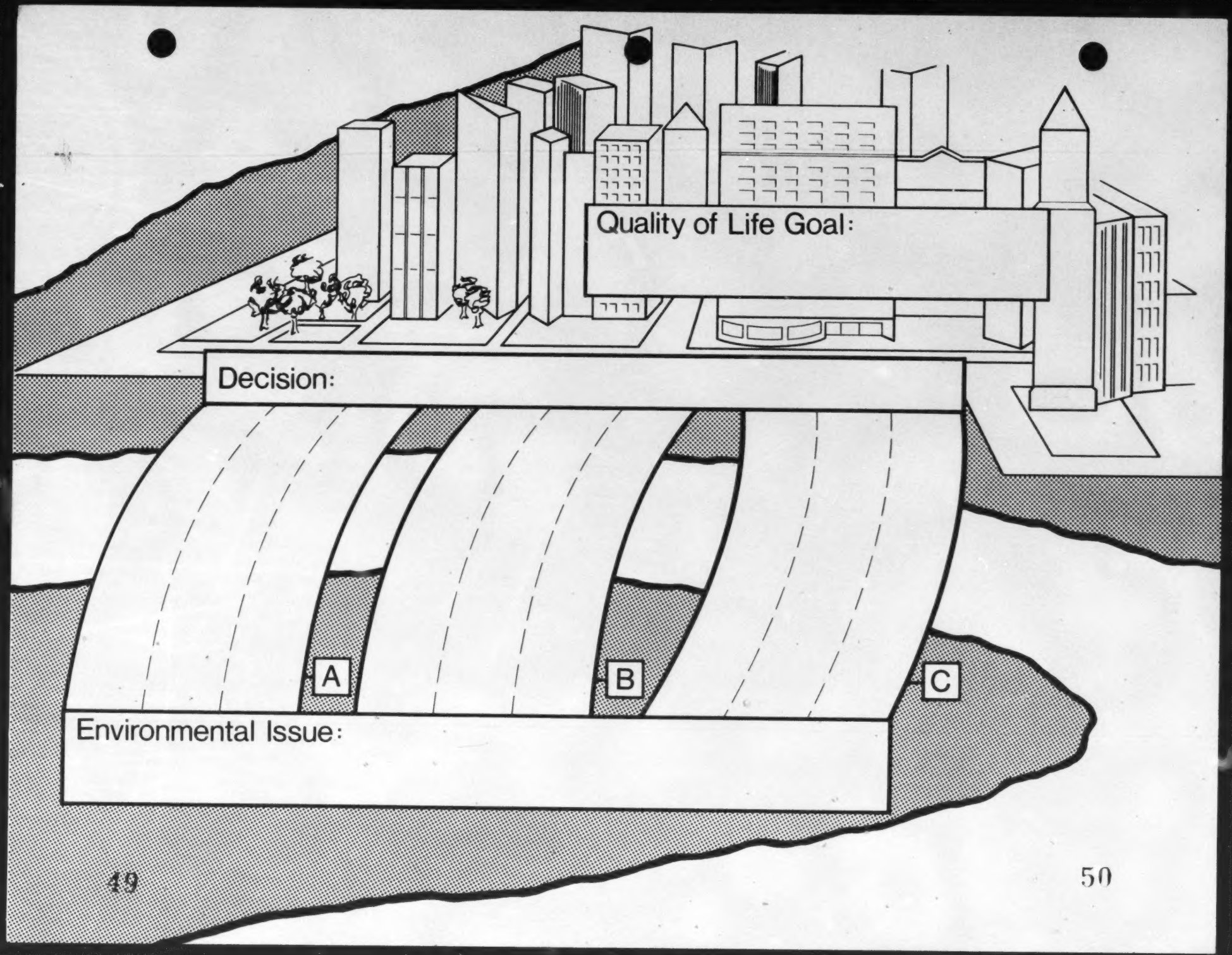
_____	a. employment (jobs)	_____	f. parks and forests
_____	b. environment (healthy air)	_____	g. personal convenience
_____	c. general health and safety	_____	h. recreational facilities
_____	d. mass transit	_____	i. _____
_____	e. new industries	_____	j. _____

2. What seems to be a desirable air quality goal for Allegheny County? (Check one.)

   _____ a. significantly improve air quality
   _____ b. slightly improve air quality
   _____ c. maintain present air quality
   _____ d. decrease air quality somewhat if it means more industrial development and jobs
   _____ e. don't worry about air quality

3. What will the goal you just selected mean for other aspects of your life and your community? Indicate whether achieving your air quality goal would increase or decrease each of items listed below -- or leave it the same as it is now. (Check the column that applies.) Space is provided to add other things that might be affected.

Air Quality Side Effects	Increase	Decrease	Same
a. industry and manufacturing			
b. automobile traffic			
c. use of electricity			
d. pollution-related diseases			
e. job opportunities			
f. my present lifestyle			
g. _____			
h. _____			


Quality of Life Goal:
Decision:
A
B
C
Environmental Issue:

Urban Air Quality: At What Costs?

MODULE EVALUATION

Please complete immediately after module use and return to C. Cornbleth, 4A01 Forbes Quadrangle, University of Pittsburgh, Pittsburgh, PA 15260.

Teacher _____ School _____

Address _____

Grade/Subject Area _____ Date _____

A. Module Use Checklist

Please indicate whether you and/or your students used each section of this module by circling either YES or NO.

YES NO 1. Overview

YES NO 2. Teacher Background Information

YES NO 3. Activity Preview

YES NO 4. Pretest

(Activity 1. The Air Is Everywhere But What Is It?)

YES NO 5. The Air Is Everywhere, But What Is It?

YES NO 6. What's the PSI, Ocean Dweller?

(Activity 2. Who Are The Offenders?)

YES NO 7. Wanted: The Worst Pollutants

YES NO 8. Wanted

(Activity 3. Air Quality: Where?)

YES NO 9. Measuring Air Quality: What and Where?

YES NO 10. How Clean Is Our Air?

(Activity 4. Inversion -- A Deadly Condition)

YES NO 11. What's an Inversion? What Difference Does It Make?

YES NO 12. Graphing An Inversion

(Activity 5. Pollution Prevention -- Where Do We Stand?)

YES NO 13. Pollution Prevention: At What Costs?

YES NO 14. Trade-Offs

YES NO 15 Decision-Making Map

B. Initial Reactions

Please comment briefly on each of the following aspects of the module.

1. Importance of (knowledge, skills, and attitudinal) objectives:

2. Significance of content:

3. Appropriateness of activities (procedures, materials):

4. Useability, ease of teaching, practicality:

5. Student Reactions:

6. Your overall reaction to the module (check one):

___ Very Positive; ___ Positive; ___ Neutral or Uncertain;

___ Negative; ___ Very Negative

Thank you.